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TITLE:

B218 Weld Filler Wire Characterization for Al-Li Alloy 2195

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ABSTRACT:

NASA Marshall Space Flight Center, Lockheed Martin Space Systems- Michoud Operations, and McCook Metals have developed an aluminum-copper weld filler wire for fusion welding aluminum lithium alloy 2195. The aluminum-copper based weld filler wire has been identified as B218, a McCook Metals designation. B218 is the result of six years of weld filler wire development funded by NASA, Lockheed Martin, and McCook Metals. The filler wire chemistry was developed to produce enhanced 2195 weld and repair weld mechanical properties over the 4043 aluminum-silicon weld filler wire, which is currently used to weld 2195 on the Super Lightweight External Tank for the NASA Space Shuttle Program. An initial characterization was performed consisting of a repair weld evaluation using B218 and 4043 weld filler wires. The testing involved room temperature and cryogenic repair weld tensile testing along with fracture toughness testing. From the testing, B218 weld filler wire produce enhanced repair weld tensile strength, ductility, and fracture properties over 4043. B218 weld filler wire has proved to be a superior weld filler wire for welding aluminum lithium alloy 2195 over 4043.

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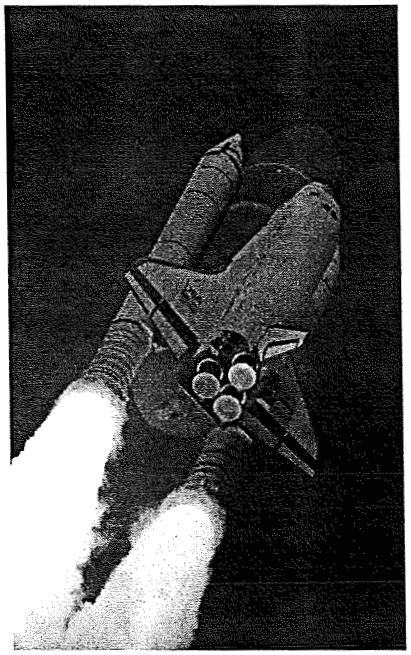
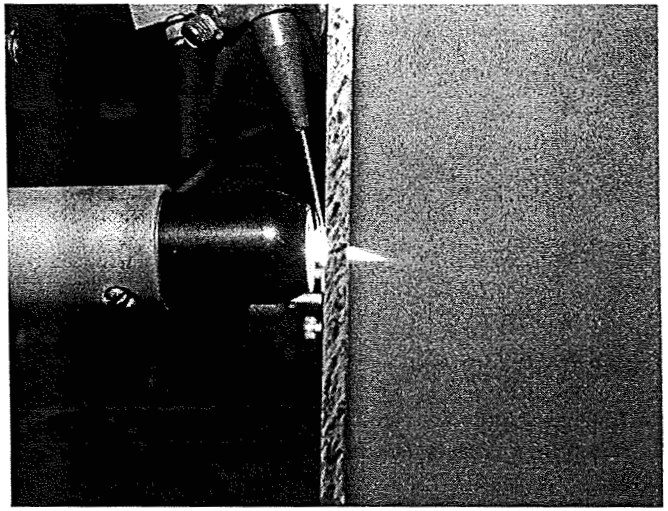
Background

- **Welding 2195 Aluminum Lithium for the Space Shuttle Super Lightweight External Tank**



NASA Space Shuttle



Variable Polarity Plasma Arc Welding

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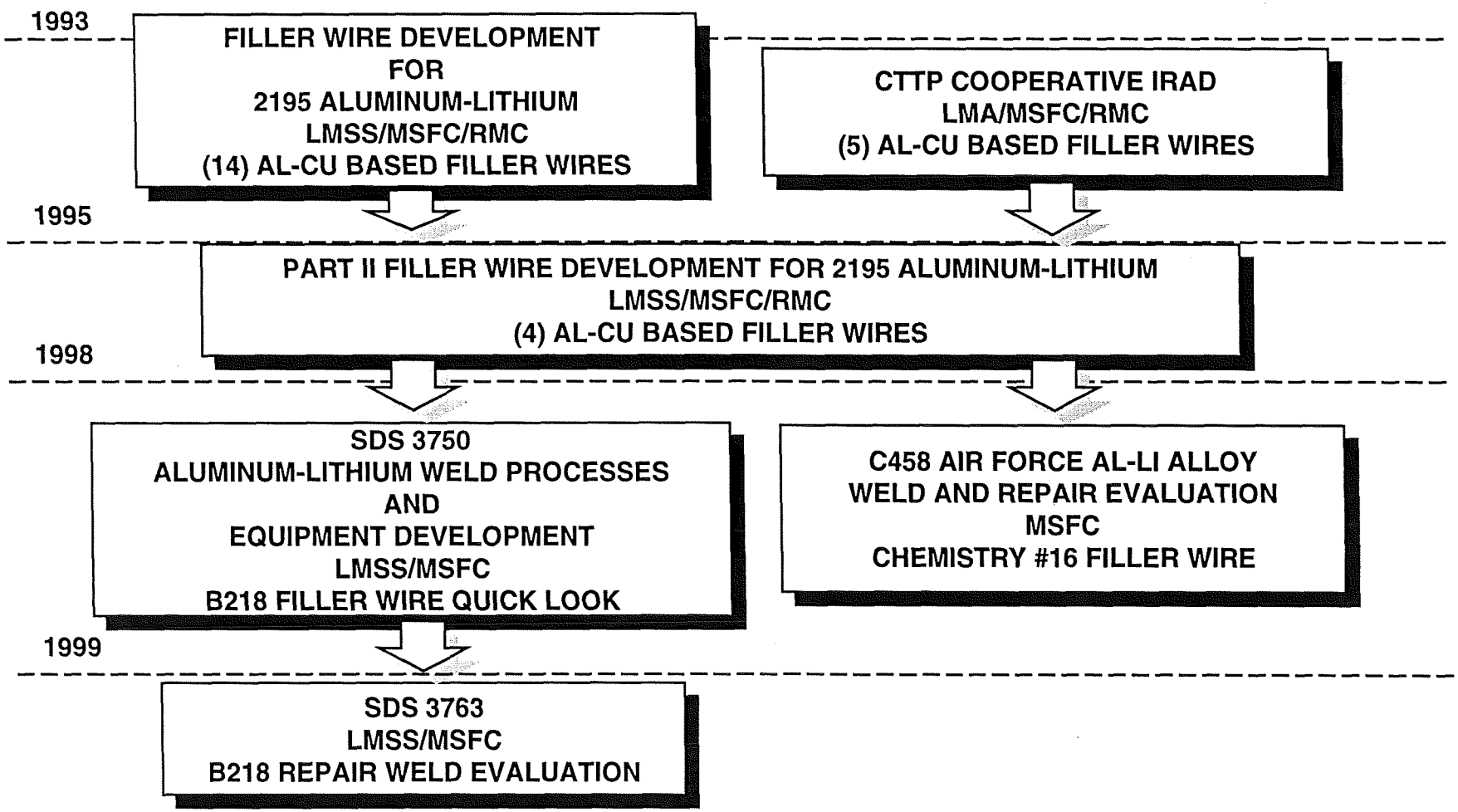
Background



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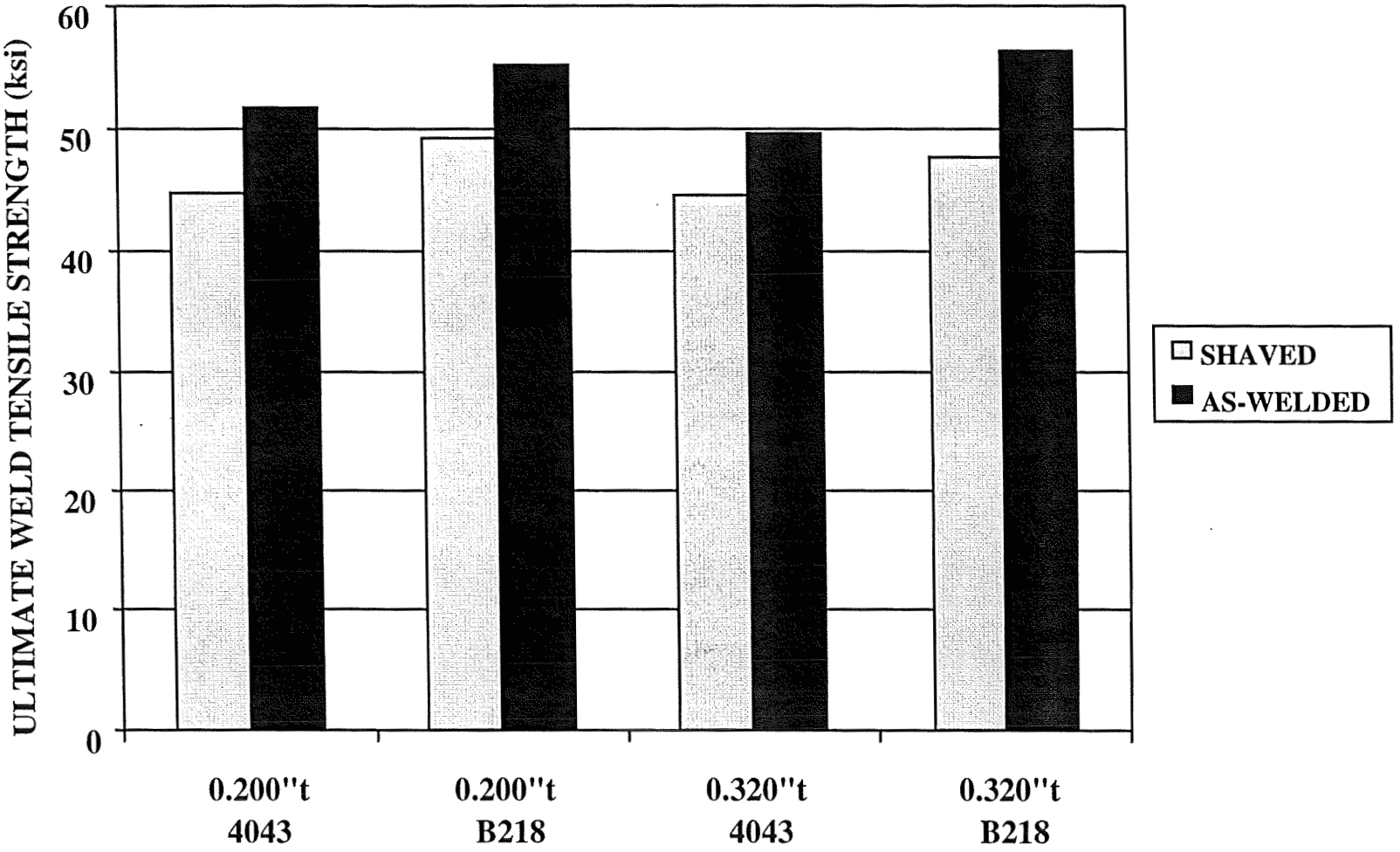
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

2195T8M4 VPPA Weld Ultimate Tensile Strength



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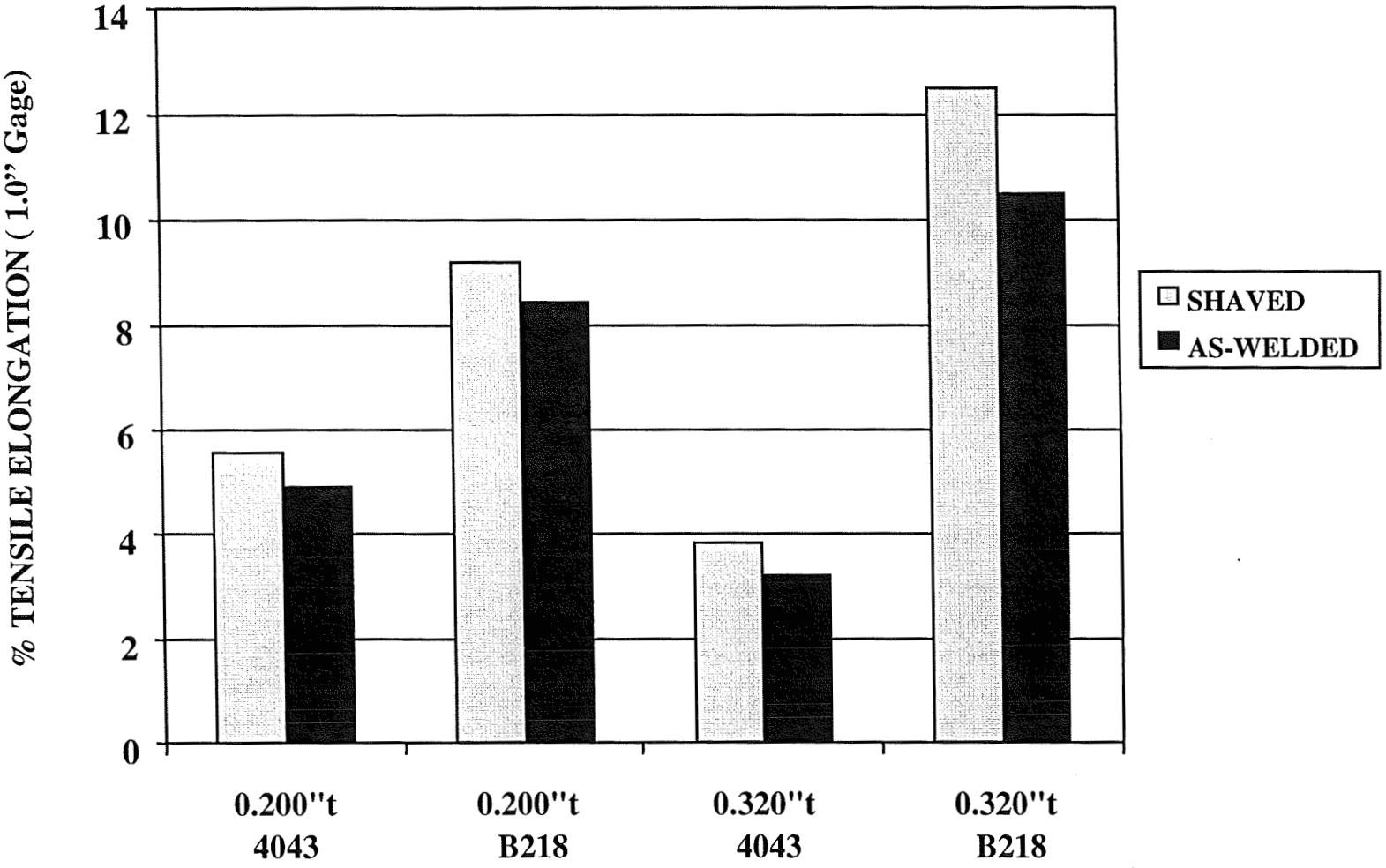
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

2195T8M4 VPPA Weld Tensile Elongation



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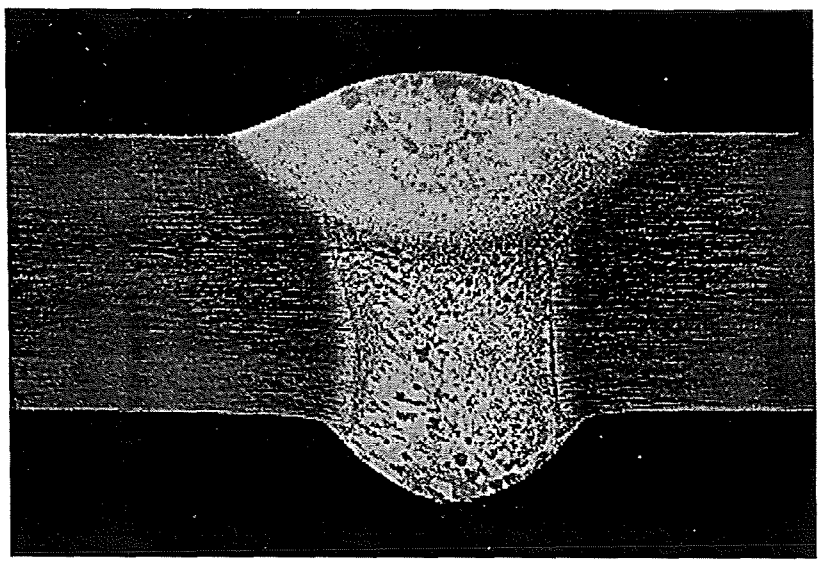
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

VPPA Weld Grain Structure Comparison

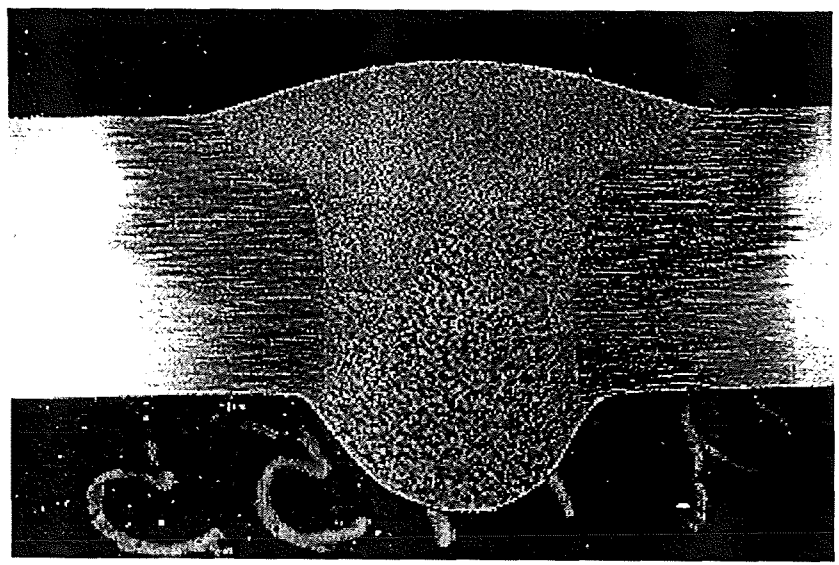
0.320t 2195 PLATE TO 2195 PLATE VPPAW

4043 WELD FILLER WIRE



10X Original Magnification

B218 WELD FILLER WIRE

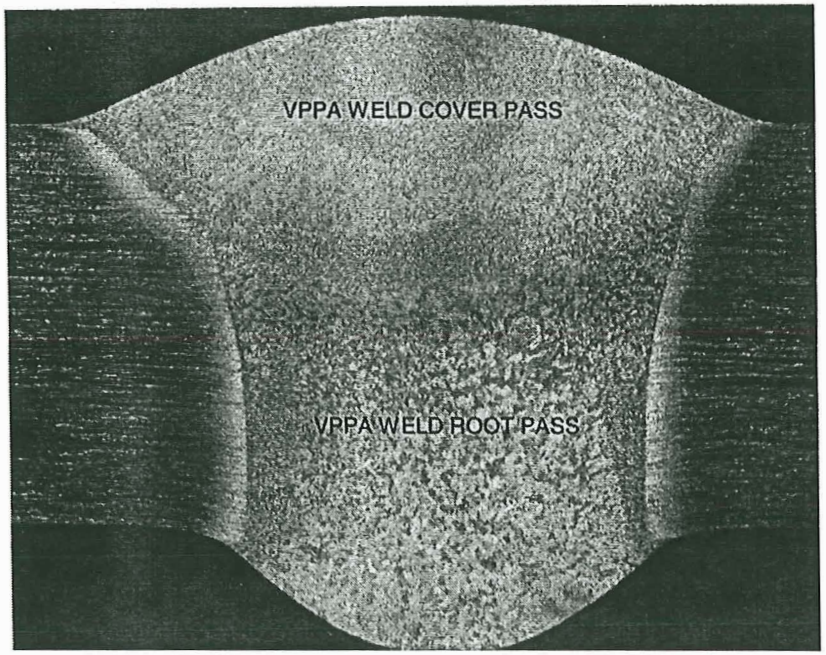


10X Original Magnification

B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

B218 VPPA Weld Grain Structure

0.200t 2195 PLATE TO 2195 PLATE VPPAW



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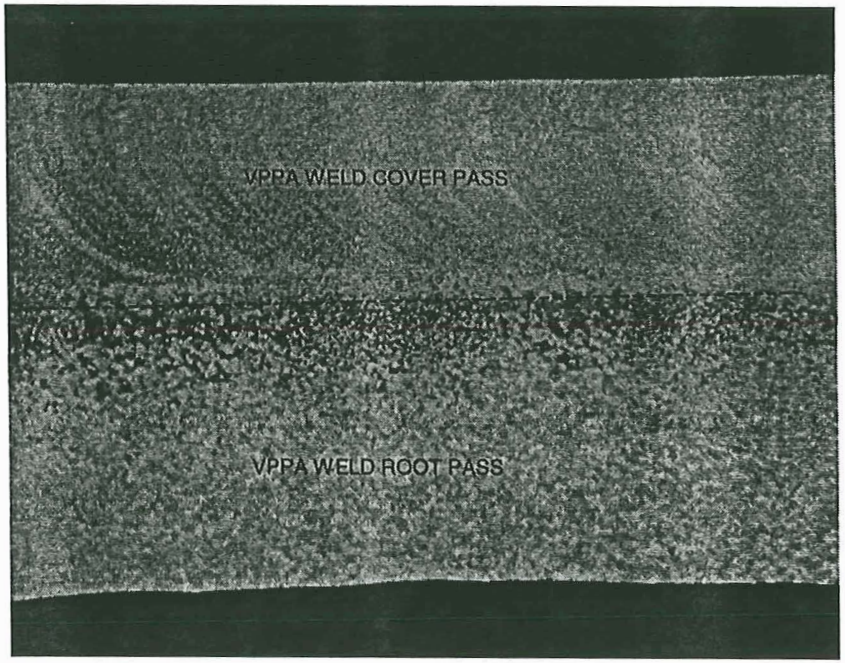
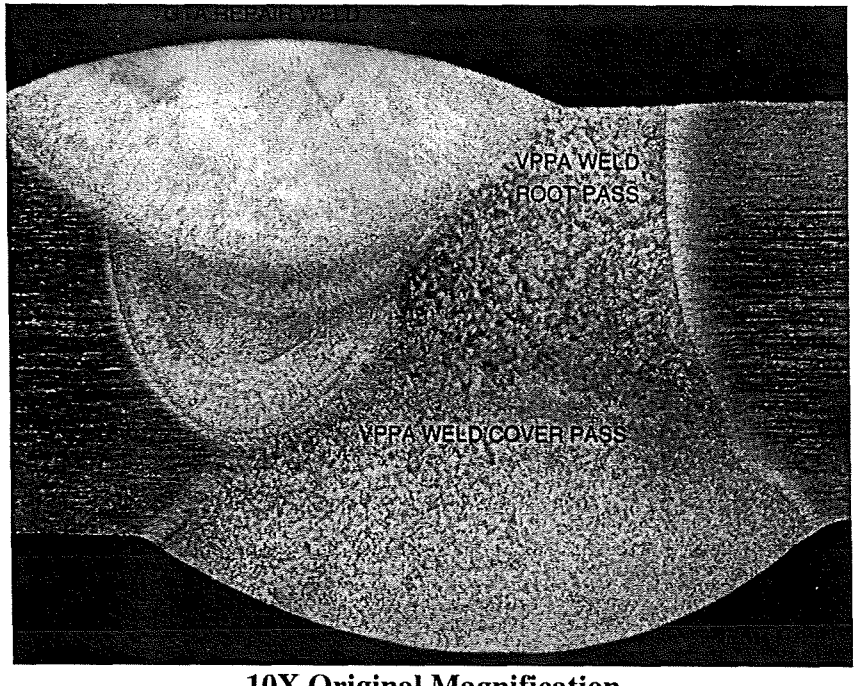


10X Original Magnification

B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

B218 GTA Repair Weld Grain Structure

R1 GTA Repair 0.200t 2195 PLATE TO 2195 PLATE VPPAW



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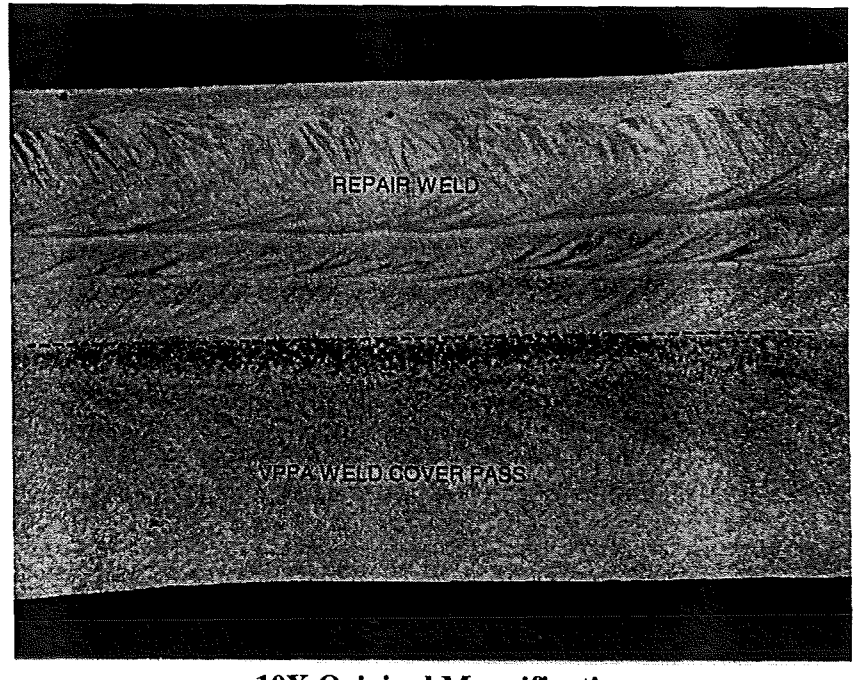
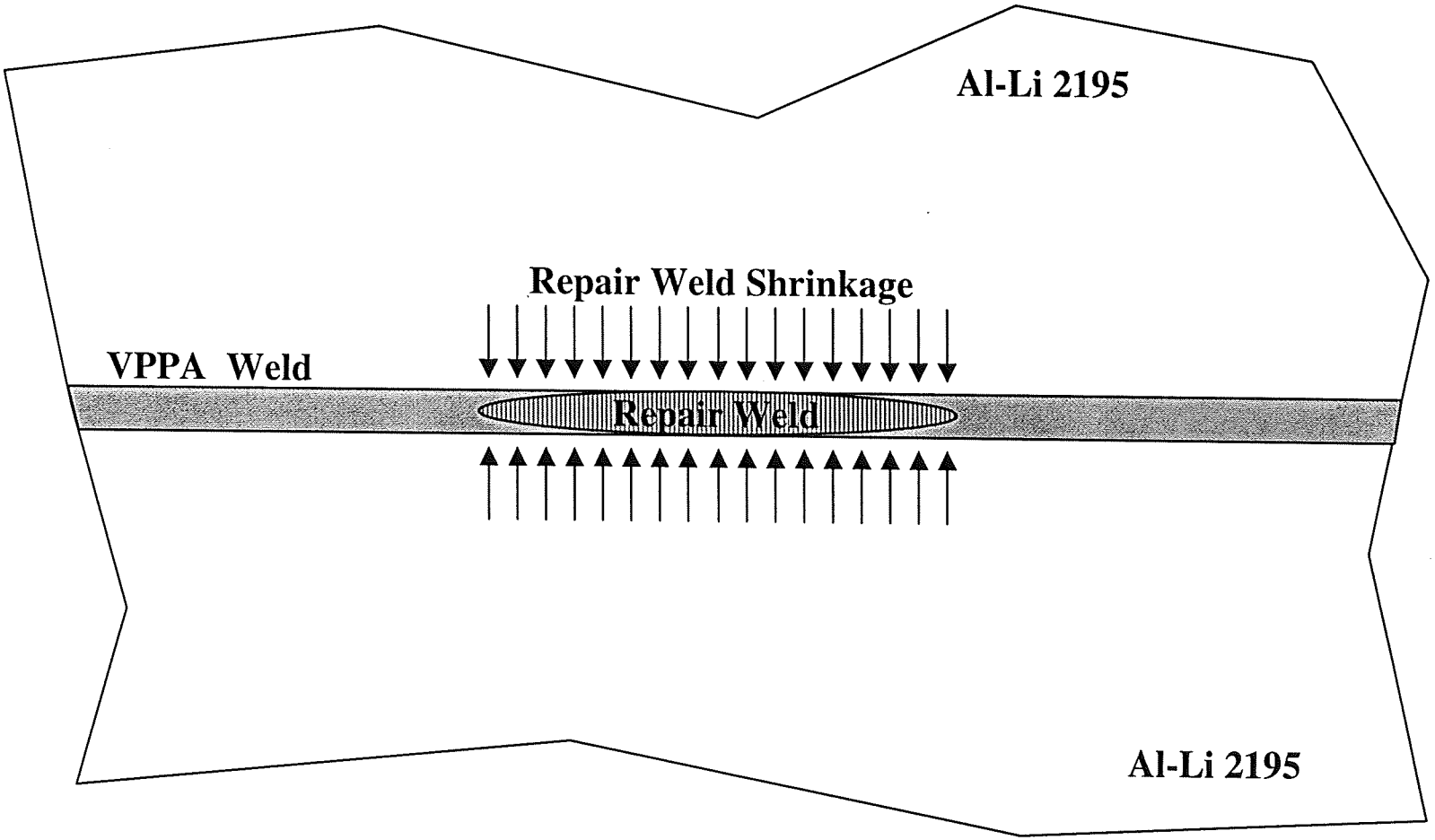


10X Original Magnification

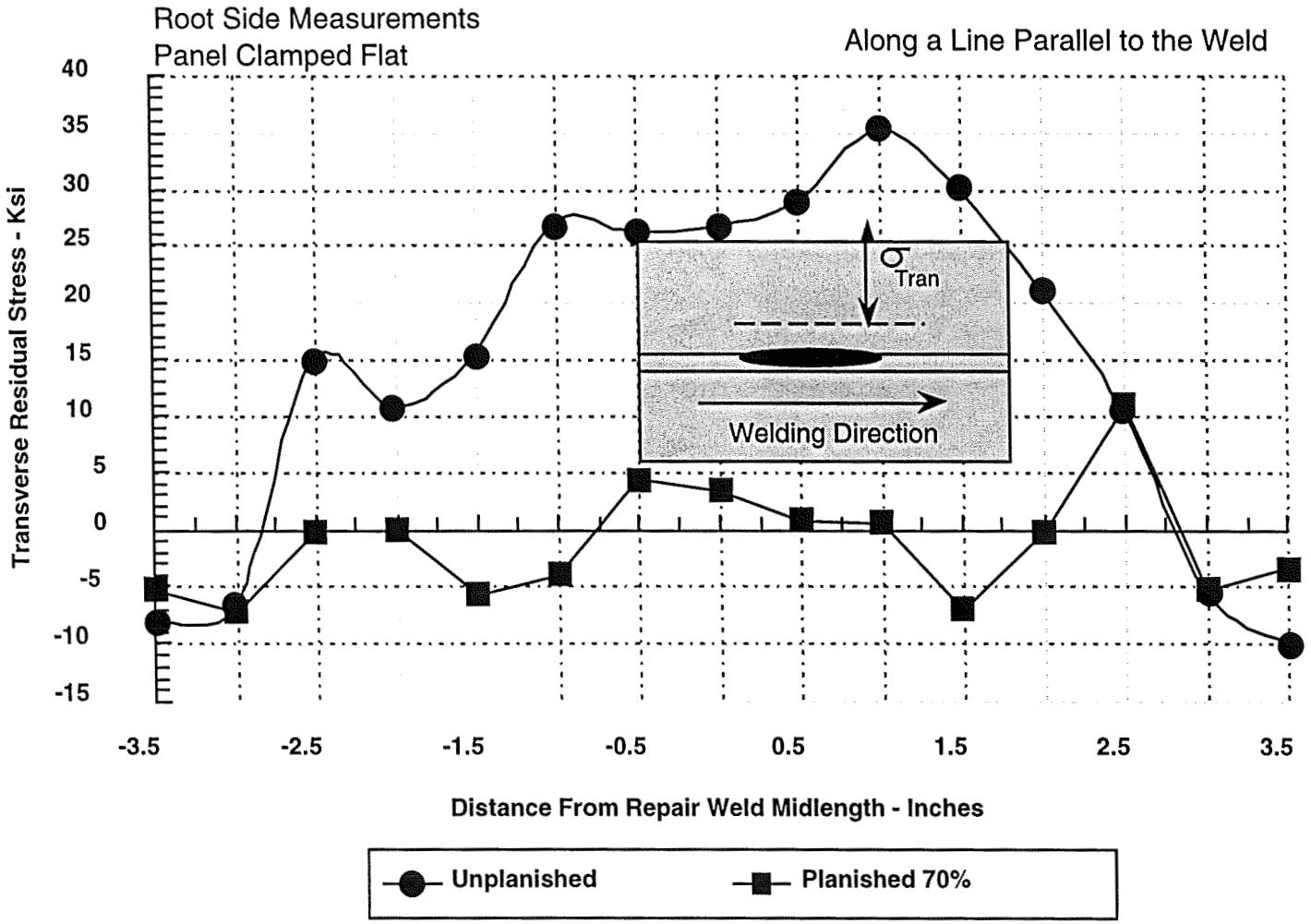
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

2195 Repair Weld Residual Stresses



B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

2195 Repair Weld Residual Stresses

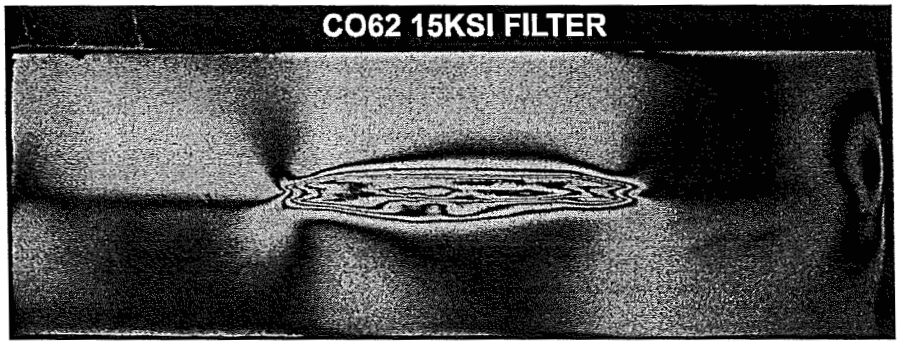


B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

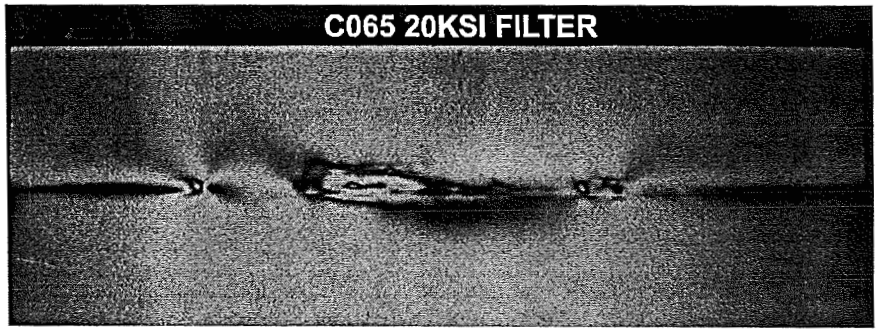
2195 Repair Weld Residual Stresses

R5 GTA Repair 0.200t 2195 PLATE TO 2195 PLATE VPPAW

Photostress of Unplanished Repair Weld



Photostress of Planished Repair Weld



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B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

Objective

- Assess B218 weld filler wire for Super Lightweight External Tank production, which could improve current production welding and repair productivity.

Approach

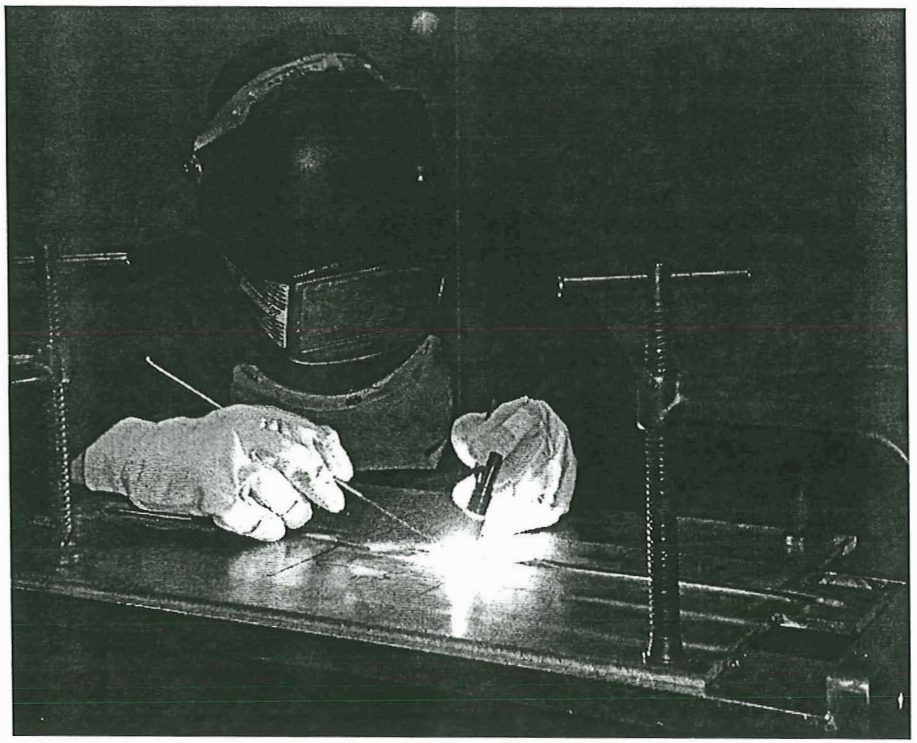
- Perform a repair weld quick look evaluation between 4043/B218 and B218/B218 weld filler wire combinations. Evaluate tensile properties for planished and unplanished conditions.

- Perform repair weld evaluation on structural simulation panel using 4043/B218 and B218/B218 weld filler wire combinations. Evaluate tensile and simulated service fracture properties for planished and unplanished conditions.

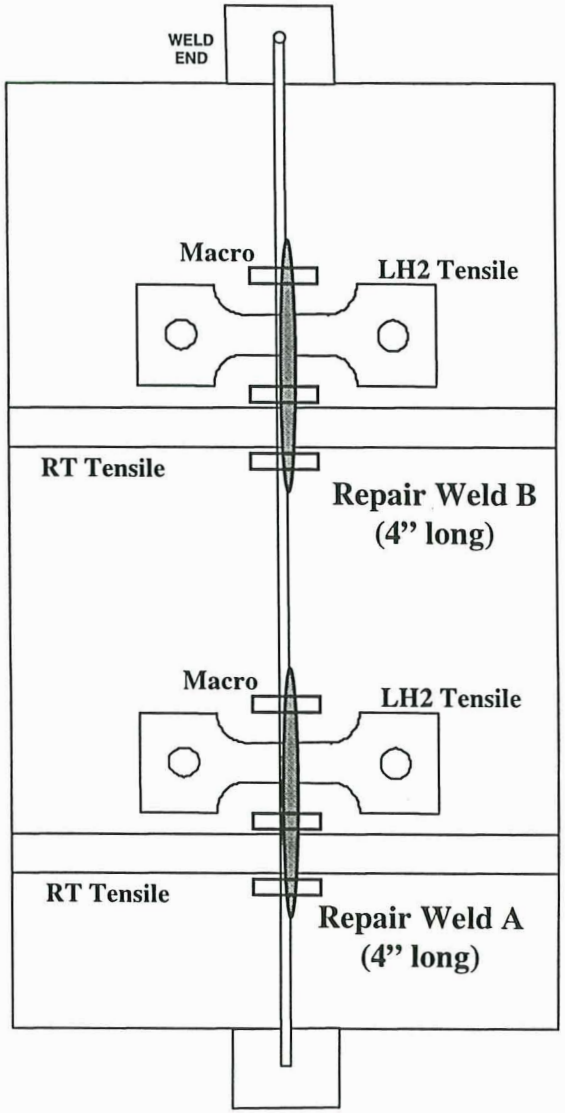
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

VPPA/GTA Repair Weld Quick Look

- 14" X 24" Standard Repair Weld Panel



Manual GTA Repair Welding



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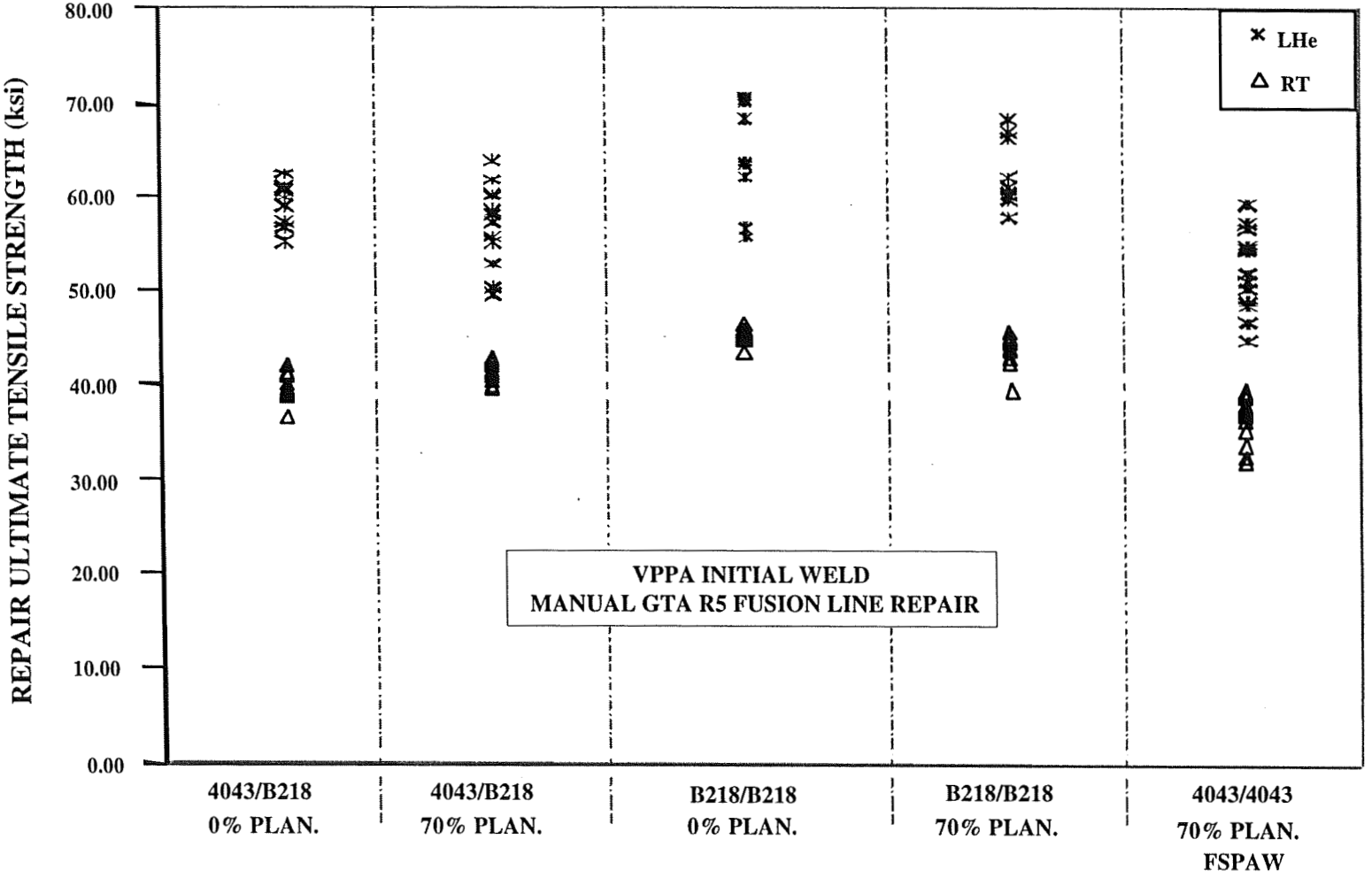
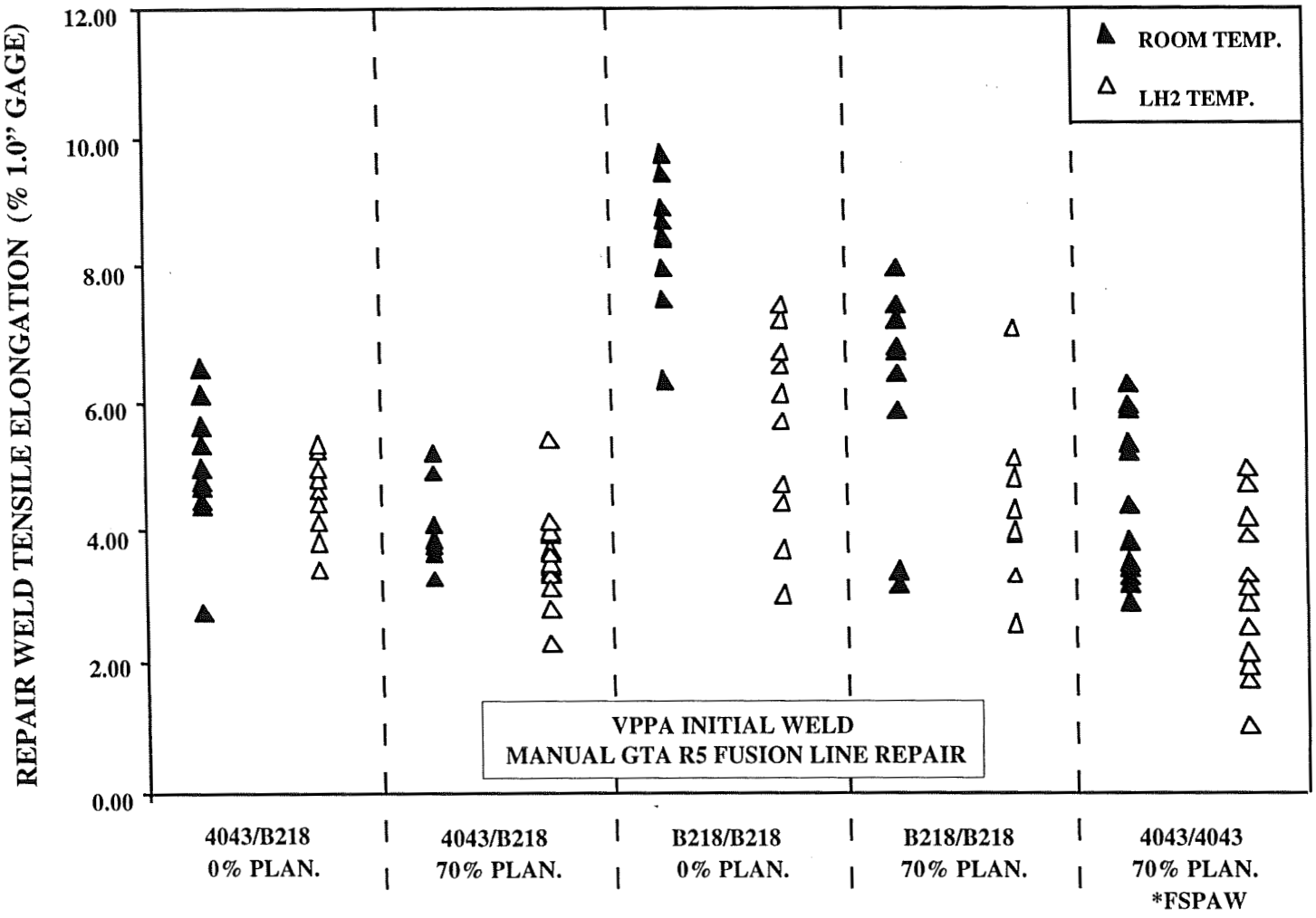
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.200"t 2195T8M4 Repair Weld Ultimate Tensile Strength -Coupon Level



B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

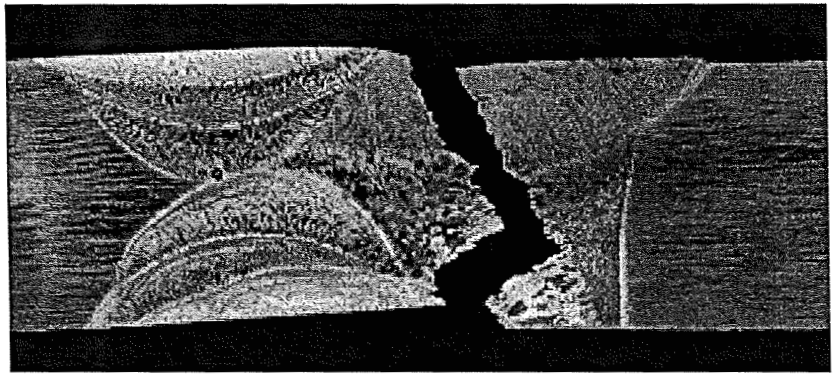
0.200"t 2195T8M4 Repair Weld Ultimate Tensile Elongation - Coupon Level



B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.200t 2195T8M4 VPPA/ GTA Repair Weld Metallography

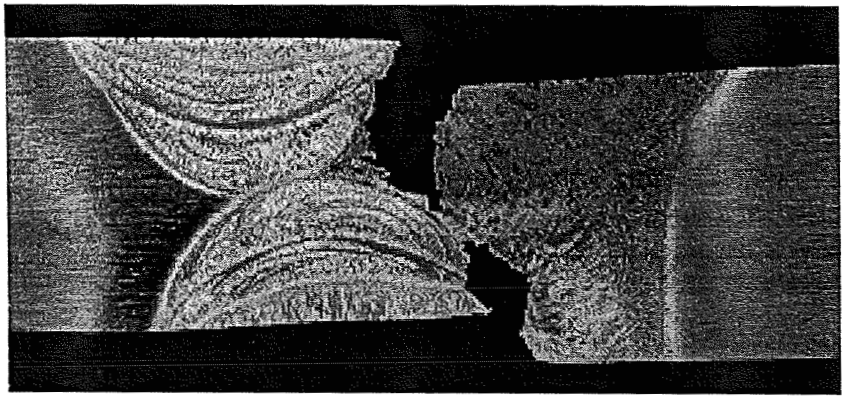
- **4043/B218 0% Planished**



7X Original Magnification

C008-RT02
RT Tensile Test
36.2 ksi / 2.74%El. 1" gage

C009-CT01
LH2 Tensile Test
62.5 ksi / 3.4%El. 1" gage

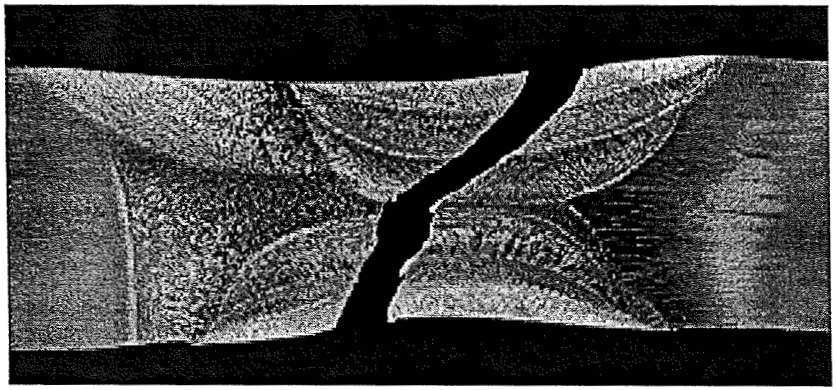


7X Original Magnification

B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.200t 2195T8M4 VPPA/ GTA Repair Weld Metallography

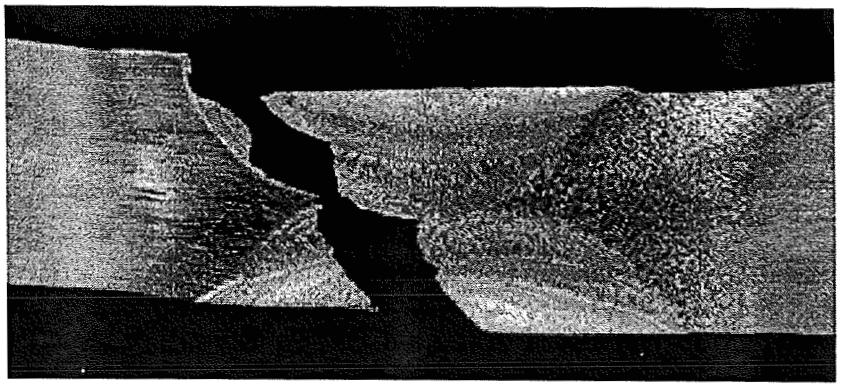
- **B218/B218 0% Planished**



7X Original Magnification

C080-RT01
RT Tensile Test
45.2 ksi / 9.75%El. 1" gage

C080-CT01
LH2 Tensile Test
68.1 ksi / 7.40%El. 1" gage

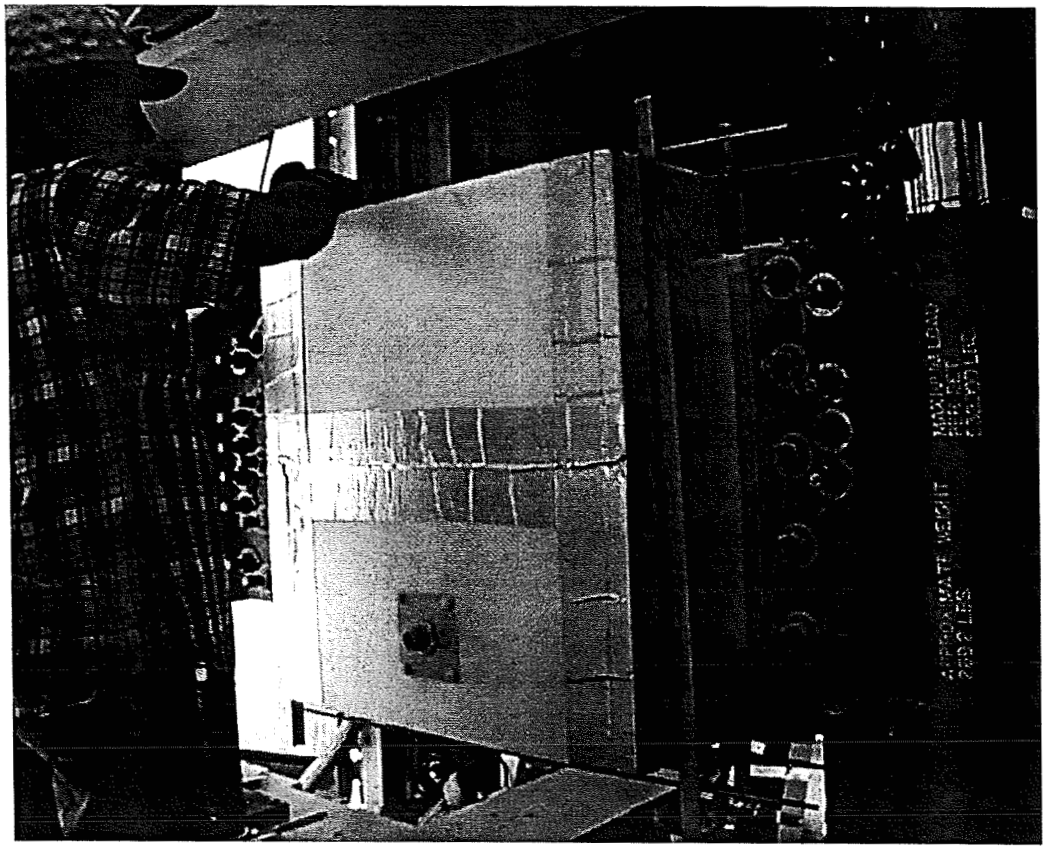


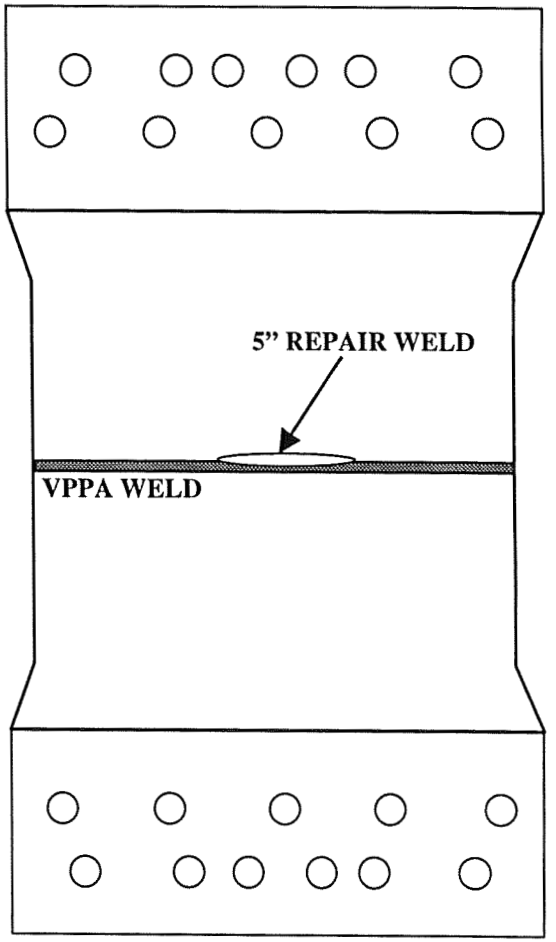
7X Original Magnification

B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

VPPA/ GTA Repair Weld Structural Simulation Panel Evaluation

- 19" X 48" Repair Weld Wide Panel





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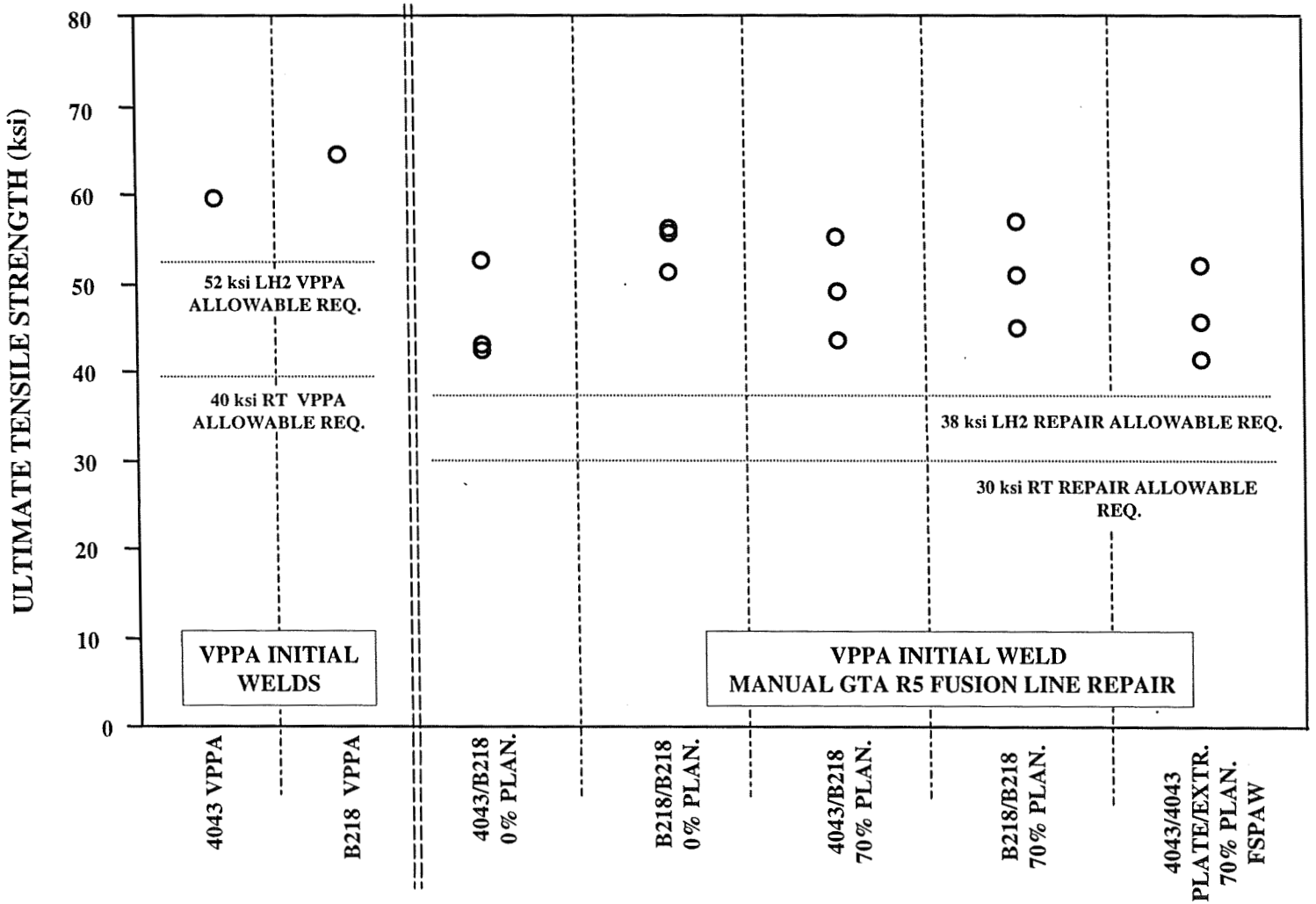
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.200t 2195T8M4 Structural Simulation Panel Weld Tensile Strength (-423°F)



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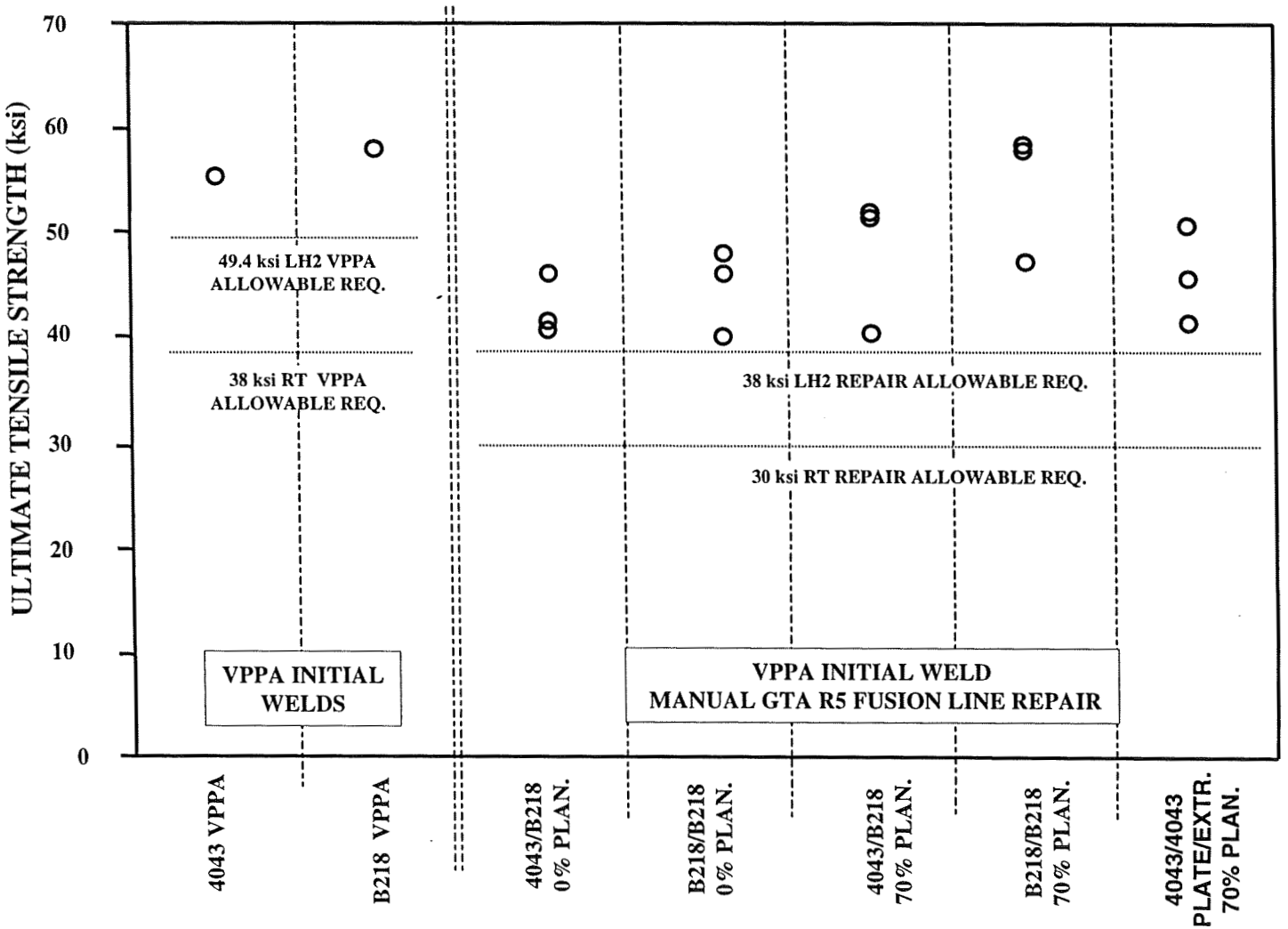
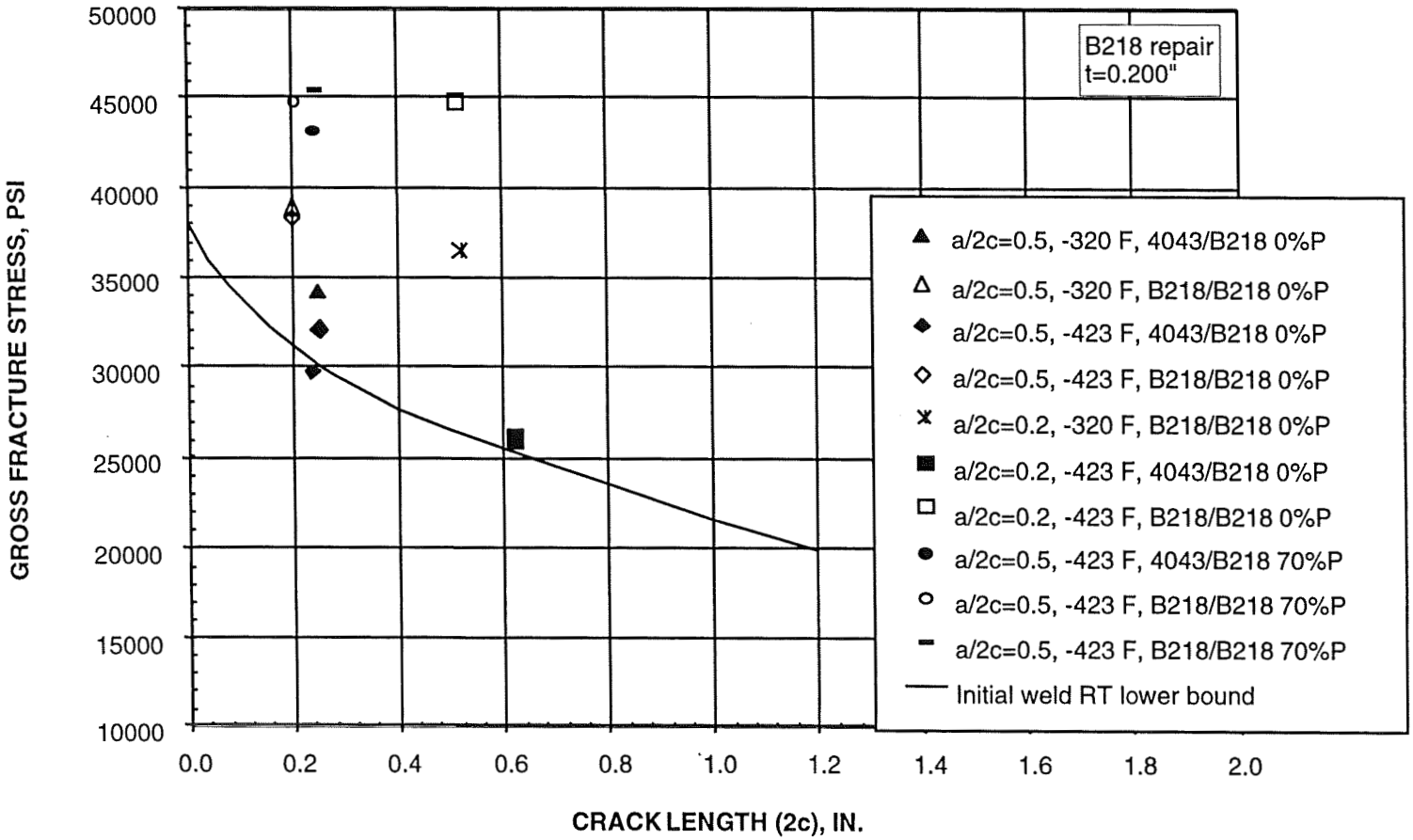
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.320t 2195T8M4 Structural Simulation Panel Weld Tensile Strength (-423°F)



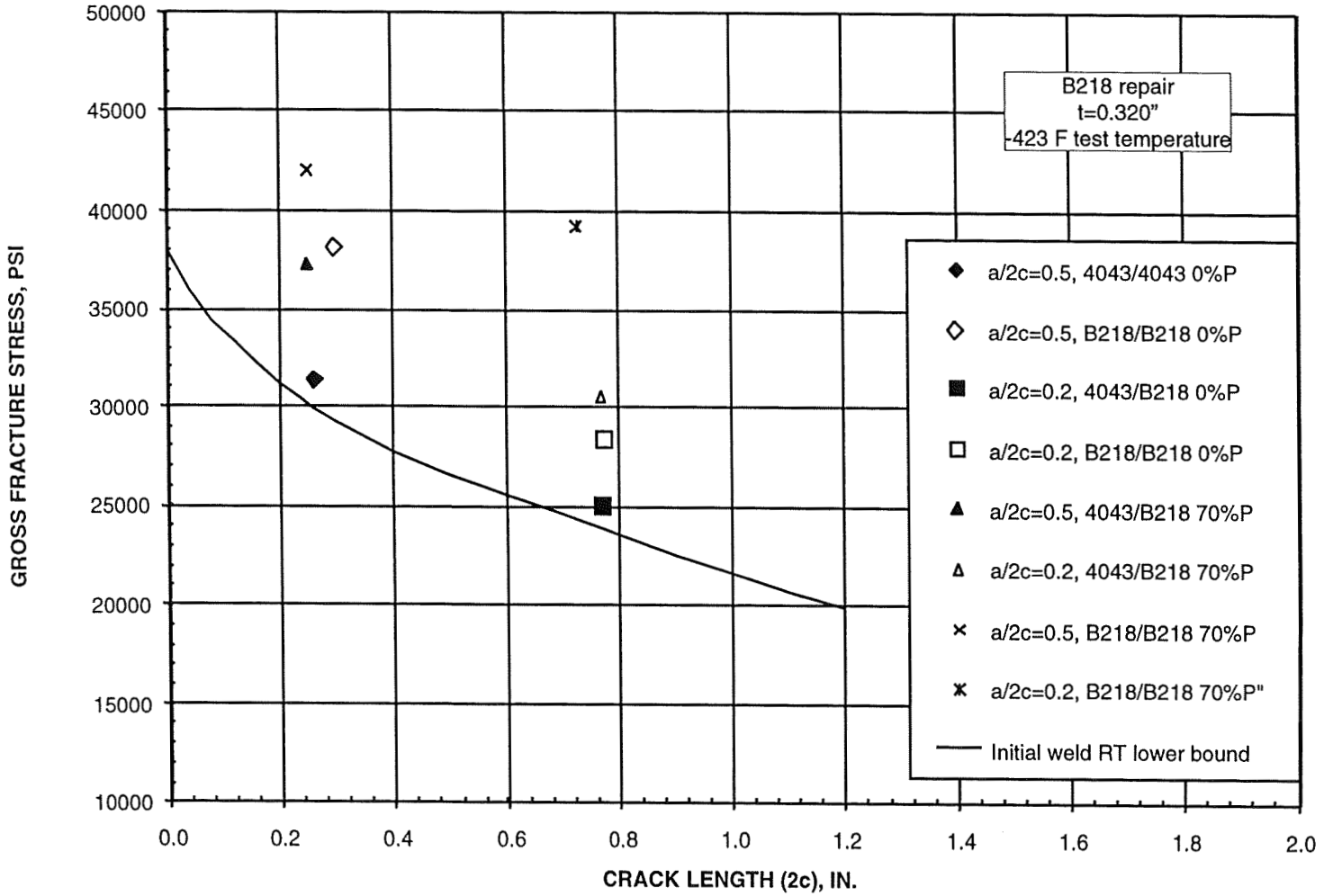
B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.200t 2195T8M4 VPPA/GTA Repair Weld Simulated Service Fracture Toughness



B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

0.320t 2195T8M4 VPPA/GTA Repair Weld Simulated Service Fracture Toughness



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B218 Weld Filler Wire Characterization For Al-Li Alloy 2195

Conclusions

- **B218 weld filler wire displayed higher repair weld tensile strength and ductility compared to 4043.**
- **Unplanished and planished B218 repair welds exceeded the current SLWT 4043 repair weld tensile strength requirement.**
- **B218 repair weld simulated service results surpassed 4043 repair welds and were comparable to 2195 initial welds made with 4043.**
- **B218 displays a high potential for improving SLWT production through increased repair weldability and the reduction/elimination of planishing for the removal of repair weld residual stresses.**